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Description

INFLATOR

Technical Field where the Invention belongs

The present invention relates to an inflator suitable for an air bag system for an automobile.

Background Art

As an inflator for an inflating type safety system of an automobile, in order to optimally protect a passenger in accordance with a position of a seat in a vehicle such as a driver side, a passenger side and the like, various inflators are generally used. As the inflators, there have been known ones where such a pressurized gas as argon, helium or the like is used as an inflating means for an air bag.

In such an inflator, since outflow of a pressurized gas is started by rupture of a rupturable plate and an air bag is inflated and developed finally, it is important to improve the rupturing ability of the rupturable plate for enhancing an activation reliability of the inflator. Further, a structure of the inflator is required to be simplified as much as possible in order to meet a demand for size and weight reduction. Besides, there is a demand for simplification of an assembling process or the like.

In JP-A 2002-172995, there is disclosed an invention relating to a stored gas inflator. In Fig. 2 showing the invention, a main chamber 20 and a small chamber 18 are formed,

a communication hole 26 and a small hole 28 are formed in a separation wall 24 disposed between these chambers, and rupturable plates (first and second burst shims) 16 and 22 are mounted to a gas ejecting hole 14 formed in the small chamber 18 and the communication hole 26. An initiator 30 is provided in a pressurized atmosphere inside the small chamber 18, and in the description of the publication, it is described that the rupturable plate can be ruptured even by an igniter with a small output. However, in this inflator, there are the following problems.

In this inflator, even the small chamber 18 is maintained in a pressurized atmosphere. In paragraph 24 of the description of the publication, there is such a description that "P2 is approximately equal to or slightly smaller than (P1 - Pm)". Here, P2 represents a rupturing pressure for rupturing the rupturable plate 22, P1 represents a rupturing pressure for rupturing the rupturable plate 16, and Pm represents a charging pressure of a gas charged in the small chamber 18 and the main chamber 20. Considering the content of this disclosure, when the pressure in the small chamber 18 becomes higher than that in the main chamber 20 due to activation of the initiator 30, there occurs no problem when the two rupturable plates 16 and 22 are simultaneously ruptured. However, in case that the rupturable plate 22 has been ruptured first, since the pressure in the small chamber 18 escapes to the main chamber 20, a pressure rising in the entire of the small chamber 18 and the main chamber 20 becomes small, so that the rupturable plate 16 is not ruptured

and an air bag can not be normally inflated. Further, the rupturable plate 16 is not provided in the extension of the advancing direction of the impact wave at the time of activation of the initiator 30, which obviously is less reliable in view of rupturing the rupturable plate.

Fig. 3 of the same publication discloses a structure in which an igniter is disposed such that its distal end is directed to the rupturable plate 16. However, since a pressurized medium exists in the main chamber 20 and the small chamber 18 separately, two rupturable plates are required, which makes the structure complicated.

In USP2002/0093182, an inflator which ruptures a rupturable plate 9 by projecting of a piston 23 has been disclosed, as shown in Figs. 1 to 3. The paragraph 28, the following description and Fig.4 clearly explain that a hole 17c is formed in a portion of the periphery of a member 17 accommodating an igniter 11, an end portion of a member 21 is entwisted therein and the piston 23 is disposed inside. However, with such a projectile mechanism of the piston 23, the number of parts is increased and maintenance of size accuracy is complicated because of many small parts, and there is still room for improvement in theses points.

Disclosure of the Invention

An object of the present invention is to provide an inflator in which a mounting work to a module can be performed easily and reliability in activation of the inflator is enhanced.

The invention described in claim 1 provides, as one means for solving the above problem, an inflator comprising a cylindrical inflator housing which is closed at one end thereof and is opened at the other end and in which a pressurized gas is charged, and a diffuser portion which is connected to an opening portion of the inflator housing, accommodates an igniter and has a gas discharge port, wherein

at least one portion of a gas discharge passage existing from the inflator housing to the gas discharge port of the diffuser portion is closed by a flat plate-shaped rupturable plate;

an igniter for rupturing the rupturable plate is disposed such that an axial direction of the inflator housing is orthogonal to an axial direction of the igniter and the axial direction of the igniter is not exactly opposite to a surface of the flat plate-shaped rupturable plate; and

a means for directing a rupturing energy generated by activation of the igniter in the exactly opposite direction to rupture the rupturable plate.

The rupturable plate is mounted to an opening portion of the inflator housing or inside the diffuser portion. The rupturable plate is like a flat plate to be mounted, but it receives a pressure of a pressurized gas to be deformed into a bowl-like shape after the pressurized gas is charged.

Since the igniter is disposed such that the axial direction of the inflator housing and the axial direction of the igniter are orthogonal to each other, the entire inflator

can be made compact as compared with a case that, when the igniter is mounted in the same axial direction as the axial direction of the inflator housing, an additional member for gas discharging is required.

When the inflator is connected to a module in which an air bag is accommodated, it is eventually connected to a portion of the gas discharge port of the diffuser portion. However, when the igniter is mounted in the same manner as the present invention, a lead wire connected to an igniter can be extended in an opposite direction to the air bag, so that the lead wire does not interfere with a module connection at a time of mounting the inflator to the module.

By arranging, inside the diffuser, a means (for directing a rupturing energy to act) for discharging a rupturing energy (an integrated energy produced by an impact wave, a pressure rising and the like) generated by activation of the igniter in the same direction as the axial direction of the inflator housing inside the diffuser, even if a rupturing energy from the igniter is dispersed, it can be focused on the rupturable plate, so that the rupturing ability of the rupturable plate can be enhanced.

The invention described in claim 2 is constituted in the invention described in claim 1 such that the igniter has a fragile portion at a portion exactly opposite to the rupturable plate, the fragile portion is ruptured at an activation of the inflator and a rupturing energy acts on the rupturable plate from the fragile portion.

Since the igniter (an electric type igniter) has an igniting portion provided with a priming and the igniting portion is covered with a cup made from aluminum or the like, by providing the fragile portion in the cup, an ignition energy (rupturing energy) is discharged from the fragile portion when the igniter is activated.

The invention described in claim 3 is constituted in the invention described in claim 2 such that the fragile portion provided in the igniter is constituted with a combination of a hole(s) provided in a side face of a cup member covering the igniting portion of the igniter and a sealing tape closing the hole(s) from the inside of the cup member.

When the igniter is activated, the sealing tape is broken by a rupturing energy to open a hole(s) and the rupturing energy is discharged from the hole(s) towards the rupturable plate.

The invention described in claim 4 is constituted in the invention described in claim 2 such that the fragile portion provided in the igniter comprises a portion surrounded by a groove or a portion provided with a notch, which is provided in a side face of a cup member covering the igniting portion of the igniter.

The portion surrounded by the groove, which serves as the fragile portion, is one such as, for example, a groove formed in a circular shape (a continuous groove or a dotted line groove, which does not perforate). In the case of the circular groove, a portion defined by the circular groove of the cup wall receives a rupturing energy to fall off in a circular shape and to produce

a hole. And the rupturing energy is discharged from the hole towards the rupturable plate.

The portion with a notch, which serves as the fragile portion, is one such as, for example, a notch formed in a cross shape in the cup (a continuous notch or a dotted line notch which does not perforate). In the case of a notch like a cross mark, a notch in the cup wall receives a rupturing energy and the cup wall is turned up at four sides to produce a hole, and the rupturing energy is discharged from the hole towards the rupturable plate. Incidentally, it is preferable that the notch is sealed by a thin sealing tape or the like in order to prevent a priming from leaking from the notch portion or prevent moisture from entering therefrom. Alternatively, the notch is not a cross mark, but it may be a perforating notch formed as an annular broken line.

The invention described in claim 5 is constituted in the invention described in claim 1 such that a guiding passage for guiding a rupturing energy discharged from the igniter to the rupturable plate is formed in the diffuser portion, and a rupturing energy is guided to a central portion of the rupturable plate or a portion thereof near the central portion by action of the guiding passage.

As long as the guiding passage can guide a rupturing energy to the rupturable plate securely, its shape, structure or the like is not limited to a specific one. By providing such a guiding passage, the rupturable plate is ruptured unfailingly and easily.

In the invention described in claim 6, it is preferable that the guiding passage for guiding a rupturing energy discharged from the igniter to the rupturable plate comprises a cap which surrounds at least the igniting portion of the igniter and is disposed in the direction orthogonal to the axial direction of the inflator housing and a hole which is provided at a position, on a side face of the cap, which is correctly opposed to the rupturable plate.

The shape and the structure of the cup are not limited specifically, and it may be a cylindrical cap which surrounds the igniting portion of the igniter at its one end opening portion and abuts on an inner wall face of the diffuser portion at the other end opening portion.

Since the cap is positioned in the gas discharge passage, the diameter of the cap is set to be smaller than the diameter of the gas discharge passage not to block a smooth flow of the pressurized gas. It is further preferable that the length of the cap is also adjusted as well as the diameter of the cap.

The invention described in claim 7 is constituted in the invention described in claim 1 such that a cap which surrounds at least the igniting portion of the igniter and is disposed in a direction orthogonal to the axial direction of the inflator housing is provided,

a groove or a notch formed in a desired shape is provided at a portion, in a peripheral face of the cap, which is exactly opposite to the rupturable plate; and

a portion of the cap having the desired shape is deformed

to fall down towards the rupturable plate and come in contact with the rupturable plate by action of a rupturing energy discharged from the igniter.

In the invention described in claim 7, it is preferable that the desired shape portion formed by the groove or the notch has an arrowhead shape for making it easy to rupture the rupturable plate.

In the inventions described in claims 7 and 8, the rupturable plate is ruptured by a multiplier effect of an impact due to collision to the deformed portion of the cap, impact of a rupturing energy itself discharged from the hole produced at the deformed portion and an increase of an internal pressure. Alternatively, the rupturable plate may by ruptured only by the impact due to a collision to the deformed portion of the cap.

Since the deformed portion is integrated with the cap before activation of the igniter in this manner, such a member as the independent piston shown in USP 2002/0093182 is not required. Further, in case of rupturing the rupturable plate by the multiplier effect, the plate is not ruptured by a single means such as a piston in the above prior art, so that the deformed portion dose not have to be necessarily thick.

The invention described in claim 9 is constituted in any one of claims 1 to 8 such that the pressurized gas is charged in a single space.

By charging the pressurized gas in the single space , the structure and assembling of the inflator can be simplified because the charging of the pressurized gas can be achieved

rapidly at a time.

The invention described in claim 10 provides, as another means for solving the above problem, an inflator comprising a cylindrical inflator housing which is closed at one end thereof and is opened at the other end and in which a pressurized gas is charged, and a diffuser portion which is connected to the opening portion of the inflator housing, accommodates an igniter therein and has a gas discharge port, wherein

at least one portion of a gas discharge passage existing from the inflator housing to the gas discharge port of the diffuser portion is closed by a flat plate-shaped rupturable plate, and the pressurized gas is charged in a single space;

an igniter for rupturing the rupturable plate is disposed in the single space charged with the pressurized gas such that the axial direction of the inflator housing and the axial direction of the igniter obliquely cross with each other; and

a means causing a rupturing energy generated by activation of the igniter to act in an oblique direction to the rupturable plate to rupture the rupturable plate.

The angle defined between the axial direction of the inflator housing and the axial direction of the igniter is preferably an acute angle, more preferably an angle of 60° or less, further preferably an angle of 50° or less, and especially preferably an angle of 40° or less.

The invention described in claim 10 can make the whole inflator further compact compared with the inventions described in claims 1 to 9. Further, in the invention described in claim

10, the same effect as that in the invention described in claim 1 can also be achieved. Furthermore, by charging the pressurized gas in the single space, the structure of the inflator can be simplified.

The invention described in claim 11 is constituted in the inventions described in claims 1 to 10 such that a diffuser tube having a second gas discharge port is further connected to the gas discharge port of the diffuser portion.

By using the above diffuser tube , mountability of the inflator to the module can be improved by adjusting the diameter or the length of the diffuser tube according to the shape of the module while maintaining the shape of the diffuser portion unchanged.

The invention described in claim 12 is constituted in the invention described in claim 11 such that the diffuser tube is arranged such that the diffuser tube is coaxial to the inflator housing or the central axis of the inflator housing and the central axis of the diffuser tube are parallel to each other.

In the inventions described in claims 11 and 12, the diffuser tube has plural second gas discharge ports in a peripheral face thereof, and it is preferable that the plural second gas discharge ports are provided circumferentially at equal intervals.

By forming the gas discharge ports in this manner, even when the inflator is activated due to a fire or the like and the pressurized gas is ejected from the gas discharge port during transportation to storage of the inflator, the inflator

is prevented from jumping out like a rocket. For example, when only a single gas discharge port is provided, the inflator jumps out like a rocket due to ejection of the pressurized gas, which is much dangerous.

The invention described in claim 14 is constituted in the inventions described in claims 1 to 13 such that a filter which catches fragments of the rupturable plate is disposed in the gas discharge passage existing from the rupturable plate to the gas discharge port or to the second gas discharge port.

According to the inflator of the present invention, an inflator can be made compact entirely and a mounting workability of the inflator to a module during assembling of an air bag system can be improved. Further, since a rupturing ability of a rupturable plate at the time of actuation of an inflator is improved, the reliability of the inflator can be more improved as a product.

Brief Description of the Drawings

Fig. 1 is an axial partially sectional view of an inflator;

In Fig. 2, Fig. 2(a) is an axial partially sectional view of an inflator and Fig. 2(b) is a radial partially sectional view of the inflator;

In Fig. 3, Fig. 3(a) is an axial partially sectional view of an inflator and Fig. 3(b) is a radial partially sectional view of the inflator;

In Fig. 4, Fig. 4(a) is an axial partially sectional view

of an inflator, Fig. 4(b) is a radial partially sectional view of the inflator, and Fig. 4(c) is a radial partially sectional view showing an activation state of the inflator;

In Fig. 5, Fig. 5(a) is an axial partially sectional view of an inflator and Fig. 5(b) is a radial partially sectional view of the inflator; and

Fig. 6 is an axial partially sectional view of an inflator.

Description of Numerals

10, 100, 200, 300, 400, 500 inflator

12 inflator housing

19 rupturable plate

20 diffuser portion

21 gas discharge port

26 igniter

27 filter

30 diffuser tube

50 air bag

Preferred Embodiment of the Invention

(1) Embodiment 1

One embodiment will be explained with reference to Fig. 1. Fig. 1 is an axial partially sectional view of an inflator 10.

A cylindrical inflator housing 12 has an opening portion at one end, and the other end closed. The inner space 14 thereof is charged with a pressurized medium comprising an inert gas

such as argon, helium or the like, or a nitrogen gas at the maximum pressure of about 70,000 kPa. Such a pressurized gas is charged in only the inner space 14.

The inflator housing 12 may be produced by swaging or spinning a pipe, and an existent gas cylinder may be utilized as the inflator housing as it is. When the swaging work or the spinning work is applied to a pipe, the pipe is closed while a thin hole serving as a charging hole for a pressurized gas is left at one end side thereof.

After the inflator housing 12 is connected with a diffuser portion 20, a pressurized gas is charged from a clearance between the thin hole provided on a peripheral face or a closed end face of the inflator housing 12 and a sealing pin inserted in the thin hole. Thereafter, the inflator housing 12 is welded at the sealing pin to be closed completely.

An outer shell of the diffuser portion 20 is formed of a diffuser portion housing 22 and an inner space 24 thereof constitutes a gas discharge passage.

On one end of the diffuser 20 is connected to an opening portion 16 of the inflator housing 12 and the other end thereof is provided with gas discharge ports 21 . A filter 27 made of a wire mesh or the like is provided inside the gas discharge ports 21. An outer connection portion of the inflator housing 12 and the diffuser portion 20 is welded and fixed.

A disc-shaped rupturable plate 19 is mounted in a connection portion between the opening portion 16 of the inflator housing 12 and the diffuser portion 20 by welding and

fixing a peripheral edge 19a thereof to a peripheral edge of the opening portion of the inflator housing 12. A pressurized gas inside the inflator housing 12 is prevented from flowing out before actuation of the inflator 10 by the rupturable plate 19.

Since the rupturable plate 19 receives a pressure of the pressurized gas to be deformed in like a bowl projecting towards the diffuser portion 20 and an apex of the projecting portion is positioned at the central portion of the rupturable plate 19, a portion of the rupturable plate including the central portion is ruptured to open a closed gas discharge passage at the time of actuation of the inflator 10.

An electric type igniter 26 is accommodated inside the diffuser portion 20 having an igniting portion projected inside the inner space 26 maintained at a normal pressure. The igniter 26 is mounted such that the central axis of the igniter 26 and the central axis of the inflator housing 12 are orthogonal to each other, and the igniter 26 is fixed by crimping one portion 22a of the diffuser portion housing 22.

The igniting portion of the igniter 26 is covered with a cup 28, a hole 29 is provided in a peripheral face of the cup 28, and the hole 29 is closed, from the inside, by a sealing tape made of aluminum to form a fragile portion. The hole 29 and the rupturable plate 19 (the central portion of the rupturable plate 19) are exactly opposite to each other.

The fragile portion can be formed by providing a portion surrounded by a groove or a portion having a notch on a side

face of the cup 28 instead of a combination of the hole 29 and the sealing tape. The portion surrounded by a groove is one such as a groove (a continuous groove or a dotted-line groove) formed in a circular shape and the portion having a notch is one such as a notch (a continuous notch or a dotted-line notch) formed in a cross shape on the cup.

One portion of the igniter 26 is protruded outside the inflator 10, the protruded portion of the igniter 26 is fitted to a connector 23, and the connector 23 is connected with a lead wire 25 for sending an activation signal and a current to the igniter 26. A direction in which the lead wire 25 extends is different from a mounting direction of an air bag 50 but it is coincident with an axial direction of the inflator housing 12.

In the inflator 10, since the extending direction of the lead wire 25 can be restricted in this manner, the air bag 50 does not interfere with a wiring work of the lead wire 25 during assembling an air bag system including the inflator 10. On the contrary, the lead wire 25 does not interfere with a work for mounting the inflator 10 to the module.

The diffuser portion 20 is connected with the diffuser tube 30 coaxially with the inflator housing 12, and the inner space 31 constitutes a gas discharge passage.

The diffuser tube 30 is connected to the diffuser portion 20 such that it encloses the gas discharge port 21 at one end opening portion thereof and the diffuser tube 30 has plural second gas discharge ports 32 on a peripheral face of the other end portion thereof.

The plural number of second discharge ports are formed on the peripheral face of the diffuser tube 30 at equal intervals. The formation of the plural number of second discharge ports at equal intervals can include, for example, four ports formed at equal intervals of an angle of 90°C, six ports formed at equal intervals of an angle of 60°C, eight ports formed at equal intervals of an angle of 45°C, as viewed from a widthwise section, and it may include a case that the number of the second gas discharge ports is an odd number if respective intervals are equal.

By arranging the plural second gas discharge holes 32 at equal intervals in this manner, even when an inflator is actuated and the pressurized gas is ejected from the second gas discharge holes 36 due to a fire or the like during transportation to storage thereof, the inflator is prevented from jumping out like a rocket. The inner space 14 of the inflator housing 12, the inner space 24 of the diffuser portion 20 and the inner space 31 of the diffuser tube 30 constitute a gas discharge passage, and the pressurized gas inside the inflator housing 12 moves in the above-described order to be discharged from the second gas discharge ports 32, thereby inflating and developing the air bag 50 mounted to cover the second gas discharge ports 32.

When the inflator 10 is actuated and the igniter 26 is activated, the priming in the igniting portion is ignited and burnt to generate an igniting energy (a rupturing energy). Since the rupturing energy breaks the sealing tape constituting

the fragile portion of the cup 28 covering the igniting portion to open the hole 29, the rupturing energy is discharged to be concentrated on the central portion of the rupturable plate 19 which is exactly opposite thereto. As a result, the rupturable plate 19 is instantaneously ruptured, and the pressurized gas in the inner space 14 moves through the gas discharge passage to be ejected from the second gas discharge ports 32, thereby inflating the air bag 50. Incidentally, since fragments of the rupturable plate 19 are caught by the filter 27, the fragments are prevented from flowing into the air bag 50.

(2) Embodiment 2

Another embodiment will be explained with reference to Figs. 2(a) and 2(b). Fig. 2(a) is an axial partially sectional view of an inflator 100 and Fig. 2(b) is a radial partially sectional view of a diffuser portion 20 in Fig. 2(a).

The inflator 100 shown in Figs. 2 has a structure similar to the inflator 10 shown in Fig. 1, and the same numerals as those in Fig. 1 are used for indicating the same parts in Figs. 2. Differences between the structure in Figs. 2 and that in Fig. 1 will be explained.

As shown in Fig. 2(a), a cylindrical guiding passage 40 for guiding a rupturing energy discharged from the igniter 26 to the rupturable plate 19 is provided inside the diffuser portion 20. An opening portion of the cylindrical guiding passage 40 at one end encloses an igniting portion of the igniter 26 and an opening portion thereof at the other end is fitted in an circular hole 22b provided in an inner wall face of the

diffuser portion housing 22. An outer diameter of the cylindrical guiding passage 40 is substantially equal to an inner diameter of the circular hole 22b.

A guiding hole 42 is provided on a peripheral face of the cylindrical guiding passage 40 and at a position exactly opposite to the central portion of the rupturable plate 19, and the guiding hole 42 is open.

The rupturable plate 19 is provided at a gas discharge port 21 which is a connection portion between the diffuser portion 20 and the diffuser tube 30. For this reason, the pressurized gas is charged in a single space comprising the inner space 14, the cylindrical guiding passage 40 in communication with the inner space 14 through a guiding hole 42, and the inner space 24.

A cylindrical filter 27 is provided inside the second discharge ports 32 provided in the diffuser tube 30.

Incidentally, as shown in Fig. 2(b), since an outer diameter of the cylindrical guiding passage 40 is adjusted not to close the inner space 24 constituting the gas discharge passage, movement of the pressurized gas is not prevented.

When the igniter 26 is activated, a priming in the igniting portion is ignited and burnt to produce an igniting energy (a rupturing energy). After the rupturing energy is discharged into the cylindrical guiding passage 40, it is discharged from the guiding hole 42 facing the central portion of the rupturable plate 19. As a result, the rupturable plate 19 is instantaneously ruptured, the pressurized gas inside the

inner space 14 and the inner space 24 moves through the gas discharge passage to be ejected from the second gas discharge ports 32, thereby inflating an air bag. In this case, since fragments of the rupturable plate 19 are caught by the filter 27, the fragments are prevented from flowing into the air bag.

(3) Embodiment 3

Another embodiment will be explained with reference to Figs. 3(a) and 3(b). Fig. 3(a) is an axial partially sectional view of an inflator 200 and Fig. 3(b) is a radial partially sectional view of a diffuser portion 20 in Fig. 3(a).

The inflator 200 shown in Fig. 3 has a structure similar to the inflator 100 shown in Fig. 2, and the same numerals as those in Fig. 1 and Fig. 2 are used for indicating the same parts in Fig. 3. Differences between the structure in Fig. 3 and that in Fig. 2 will be explained.

In an inflator 200, since the opening portion 16 of the inflator housing 12 is provided with the rupturable plate 19 and a pressurized gas is charged in only the inner space 14, the inner space 24 is always maintained at normal pressure.

The guiding hole 42 of the cylindrical guiding passage 40 is provided at a position exactly opposite to the central portion of the rupturable plate 19.

The inflator 200 operates in the same manner as the inflator 100 so that the same effect as that in the inflator 100 can be achieved. Incidentally, in this embodiment, such a structure is employed that a discharge amount of pressurized gas is adjusted at the gas discharge port 21 by throttling the

diameter of the gas discharge port 21. A similar structure can be applied in the other embodiments. Besides, adjustment of the gas discharged amount can be conducted at the second gas discharge ports 32, a clearance formed between the inner space 24 and the cylindrical guiding passage 40, and the opening portion 16 of the inflator housing 12.

(4) Embodiment 4

Another embodiment will be explained with reference to Figs. 4(a), 4(b) and 4(c). Fig. 4(a) is an axial partially sectional view of an inflator 300, Fig. 4(b) is a radial partially sectional view in a diffuser portion 20 shown in Fig. 4(a), and Fig. 4(c) is a view for explaining an operation state of the inflator 300.

The inflator 300 shown in Figs. 4 has a structure similar to the inflator 10 shown in Fig. 1, and the same numerals as those in Fig. 1 are used for indicating the same parts in Fig. 4. Differences between the structure in Fig. 4 and that in Fig. 1 will be explained.

As shown in Fig. 4(a), a cap 50 for rupturing the rupturable plate 19 utilizing a rupturing energy discharged from the igniter 26 is provided inside the diffuser portion 20. The cap 50 surrounds the igniting portion of the igniter 26 at a side of an opening portion thereof and a closed end face thereof does not abut on an inner wall face 22c of the diffuser housing 22 and a distance is provided between the closed end face and the inner wall surface.

As shown in Fig. 4(b), an arrowhead like deformed portion,

comprising four-side notches, is provided in a peripheral surface of the cap 50 at the position facing the center of the rupturable plate 19. Since a notch is not provided at a proximal end portion of the arrowhead-shaped deforming portion 52, the arrowhead-shaped deforming portion 52 is not fallen off from the peripheral face of the cap 50.

Incidentally, as shown in Fig. 4(c), by forming a distal end portion of the arrowhead-like deforming portion 52 in a slightly curved shape in advance, a contact area of the arrowhead-shaped deforming portion 52 with the rupturable plate 19 becomes small and the arrowhead-shaped deforming portion can apply a stronger impact to the central portion of the rupturable plate 19 so that the rupturing ability of the rupturable plate can be increased.

The rupturable plate 19 is provided at the gas discharge port 21 which is a connection portion between the diffuser portion 20 and the diffuser tube 30. For this reason, the pressurized gas is charged in a single space comprising the inner space 14, the inner space of the cap 50 which is in communication via the notch, and the inner space 24.

A cylindrical filter 27 is provided inside the second gas discharge ports 32 provided in the diffuser tube 30.

Incidentally, as shown in Fig. 4(b), since the outer diameter and the length of the cap 50 are adjusted not to close the inner space 24 constituting the gas discharge passage, movement of the pressurized gas is not blocked.

When the inflator 300 is actuated and the igniter 26 is

activated, the priming in the igniting portion is ignited and burnt to generate an igniting energy (a rupturing energy). Since the rupturing energy is discharged in the cap 50 and an internal pressure is increased, the notched arrowhead-shaped deforming portion 52 is pressed.

As shown in Fig. 4(c), the pressed arrowhead-shape deforming portion 52 deforms to fall down to the rupturable plate 19 and collide against the rupturable plate 19. The rupturable plate 19 is instantaneously ruptured by a multiplier effect of an impact due to collision with the arrowhead-shaped deforming portion 52, an impact of the rupturing energy itself discharged from the hole produced after the arrowhead-shaped deforming portion 52 is fallen down, and the increase in the internal pressure.

As a result, the pressurized gas in the inner space 14 and the inner space 24 moves the gas discharge passage to be ejected from the second gas discharge ports 32 and inflate an air bag. Incidentally, fragments of the rupturable plate 19 are caught by the filter 27, the fragments are prevented from flowing into the air bag.

(5) Embodiment 5

Another embodiment will be explained with reference to Figs. 5(a) and 5(b). Fig. 5(a) is an axial partially sectional view of an inflator 400 and Fig. 5(b) is a radial partially sectional view of a diffuser portion 20 in Fig. 5(a).

An inflator 400 shown in Fig. 5 has a structure similar to the inflator 300 shown in Fig. 4, and the same numerals as

those in Figs. 1 and 4 are used for indicating the same parts in Fig. 5. Differences between the structure in Figs. 5 and that in Fig. 4 will be explained.

In the inflator 400, the opening portion 16 of the inflator housing 12 is provided with the rupturable plate 19 and a pressurized gas is charged in only the inner space 14, so that the inner space 24 is maintained at normal pressure.

An arrowhead-shaped deforming portion 52, comprising four-side notches, is provided on a peripheral face of the cap 50 at a portion thereoffacing the center of the rupturable plate 19. Since a notch is not provided at a proximal end portion of the arrowhead-shaped deforming portion 52, the arrowhead-shaped deforming portion 52 is not fallen off from the peripheral face. The arrowhead-like deforming portion 52 may be formed to have a slightly curved shape at a distal end portion like the case shown in Fig 4(c).

The inflator 400 operates in the same manner as the inflator 300 so that the same effect as that in the inflator 300 can be achieved.

(6) Embodiment 6

Another embodiment will be explained with reference to Fig. 6. Fig. 6 is an axial partially sectional view of an inflator 500.

The inflator 500 shown in Fig. 6 has a structure similar to the inflator 10 shown in Fig. 1, and the same numerals as those in Fig. 1 are used for indicating the same parts in Fig. 6. Differences between the structure in Fig. 6 and that in Fig.

1 will be explained.

The igniter 26 is mounted such that the central axis of the igniter 26 becomes oblique to the central axis of the inflator housing 12.

An angle defined between the central axis of the igniter 26 and the central axis of the inflator housing 12 is an acute angle, and it is preferably 60° or less, more preferably 50° or less, and further preferably 40° or less.

The rupturable plate 19 is provided at the gas discharge port 21 which is the connection portion between the diffuser portion 20 and the diffuser tube 30. For this reason, a pressurized gas is charged in a single space comprising the inner space 14 and the inner space 24.

The cylindrical filter 27 is provided inside the second gas discharge port 32 provided in the diffuser tube 30.

As apparent from comparison between the inflator 500 shown in Fig. 6 and the inflators shown in Fig. 1 to Fig. 5, in the inflator 500, the acting direction of the rupturing energy from the igniter 26 is not exactly opposite to the rupturing plate 19 but the rupturable plate 19 and the igniting portion of the igniter 26 are much close to each other, so that rupturing ability to the rupturable plate 19 is high, and the igniter 19 is mounted in an oblique direction to the central axis of the inflator housing 12, so that the whole inflator can be made further compact.

An air bag system using the inflator of the present invention can be mounted as an air bag system where each of the

inflator shown in Fig. 1 to Fig. 6 is used and an activation signal-outputting means comprising an impact sensor and a control unit is combined with a module case in which each of the inflators shown in Fig. 1 to Fig. 6 and an air bag are accommodated.

The inflator of the present invention can be applied to various inflators such as an air bag inflator for a driver side, an air bag inflator for a passenger side, an inflator for an air bag for a side collision, an inflator for a curtain air bag, an inflator for a knee-bolster, an inflator for an inflatable seat belt, an inflator for a tubular system, and an inflator for a pretensioner.